ChevronTexaco

Codes and Standards for a Hydrogen Infrastructure

ChevronTexaco Technology Ventures

DOE Distributed Energy Resources Road Show

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Lori Long

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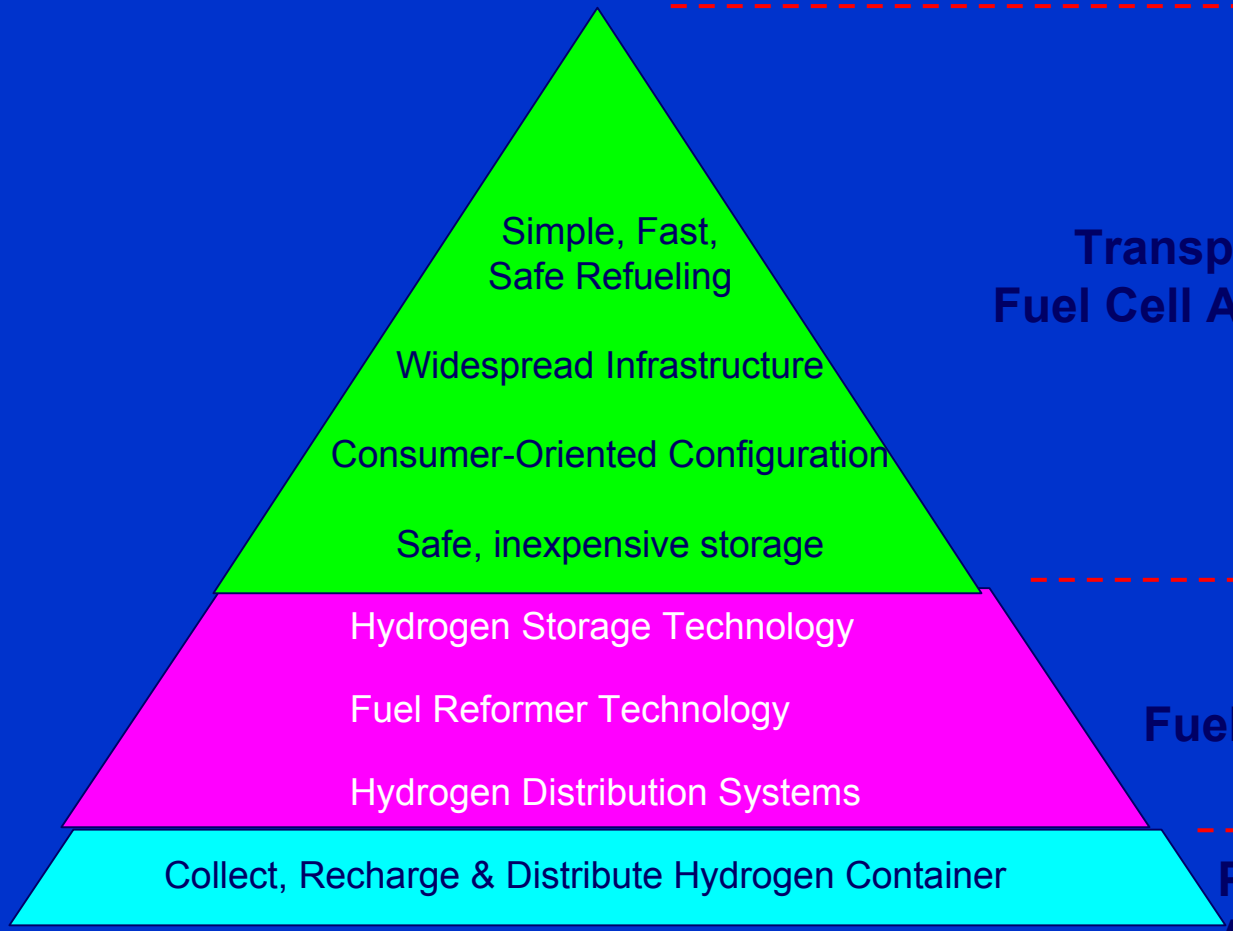
H2 Infrastructure Codes and Standards Preview

- Provide an overview of the Codes and Standards hierarchy in the U.S.
- Some of the issues and obstacles from the perspective of a newcomer to the process.
- Focusing mostly on issues relating to hydrogen infrastructure.
- This will not be a comprehensive roadmap.
- Lot's of abbreviations and acronyms – will provide a key and contact list.

Infrastructure Development Parallels Fuel Cell Development

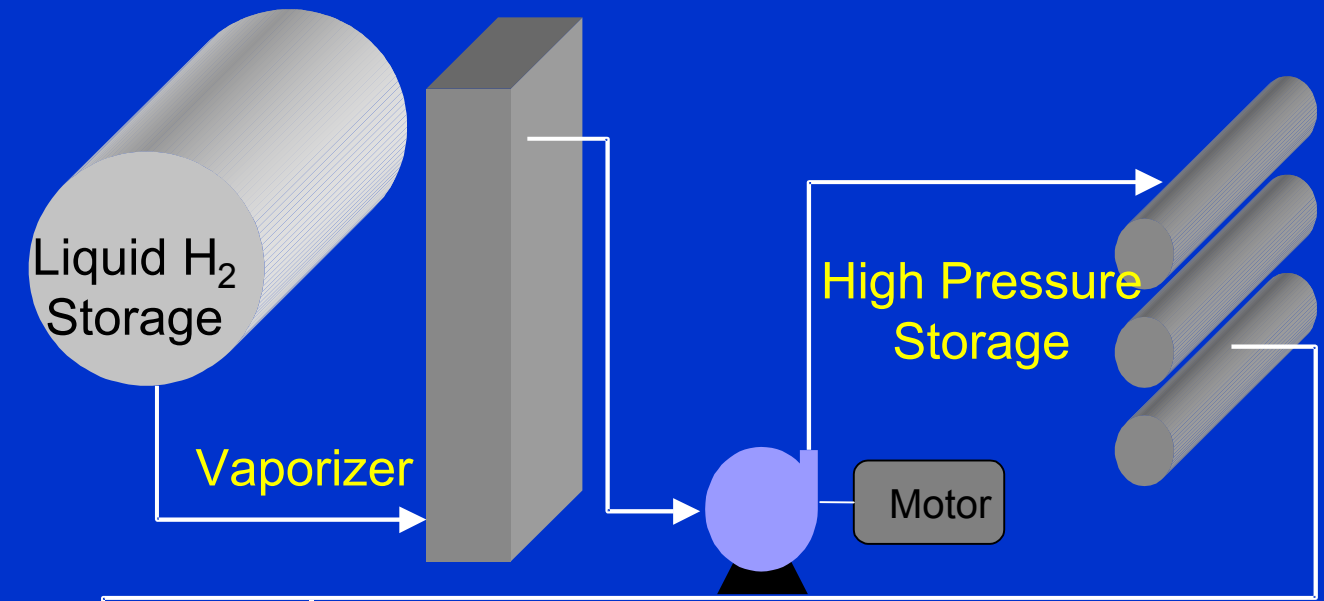


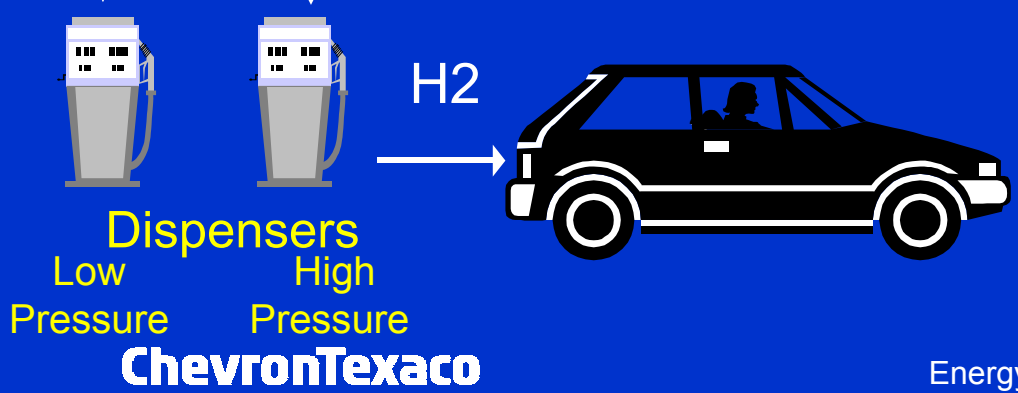
Transportation Fuel Cell Applications

Stationary Fuel Cell Applications

Portable Fuel Cell Application

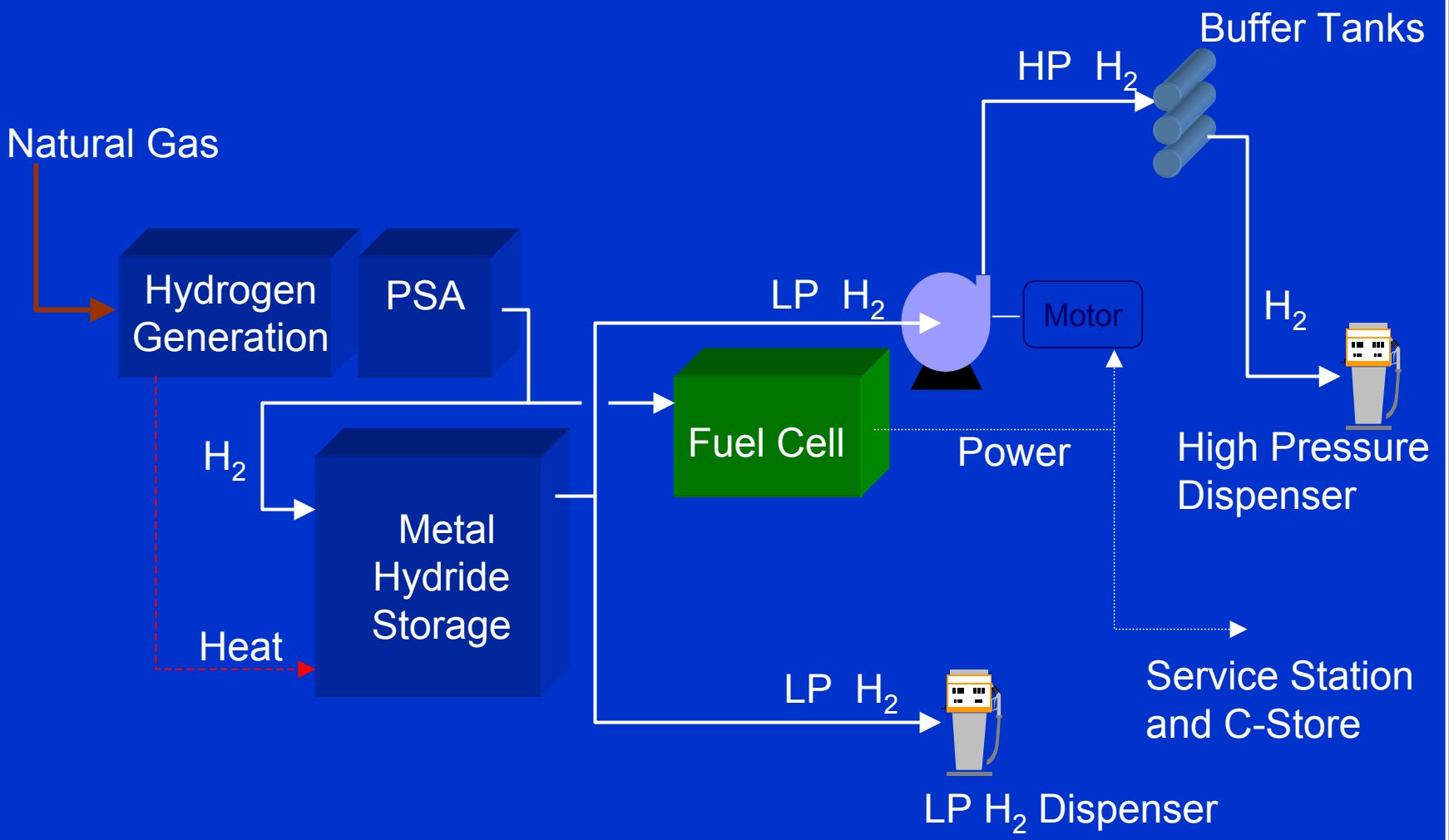
West Sacramento Hydrogen Station





Energy Tech

First Generation Energy Station



First Generation Fuel Processor

HALIAS™ Fuel Processor

120 standard liter per minute hydrogen

➢40 percent hydrogen purity

Fuel Sources – natural gas, propane

H2 Infrastructure Codes and Standards Definitions

CODE

A Document that compiles various provisions across a broad subject matter.

- It is suitable for adoption into law
- It incorporates by reference various standards
- Examples include National Electric Code (NEC) and International Fire Code (IFC).

H2 Infrastructure Codes and Standards Definitions

Standard

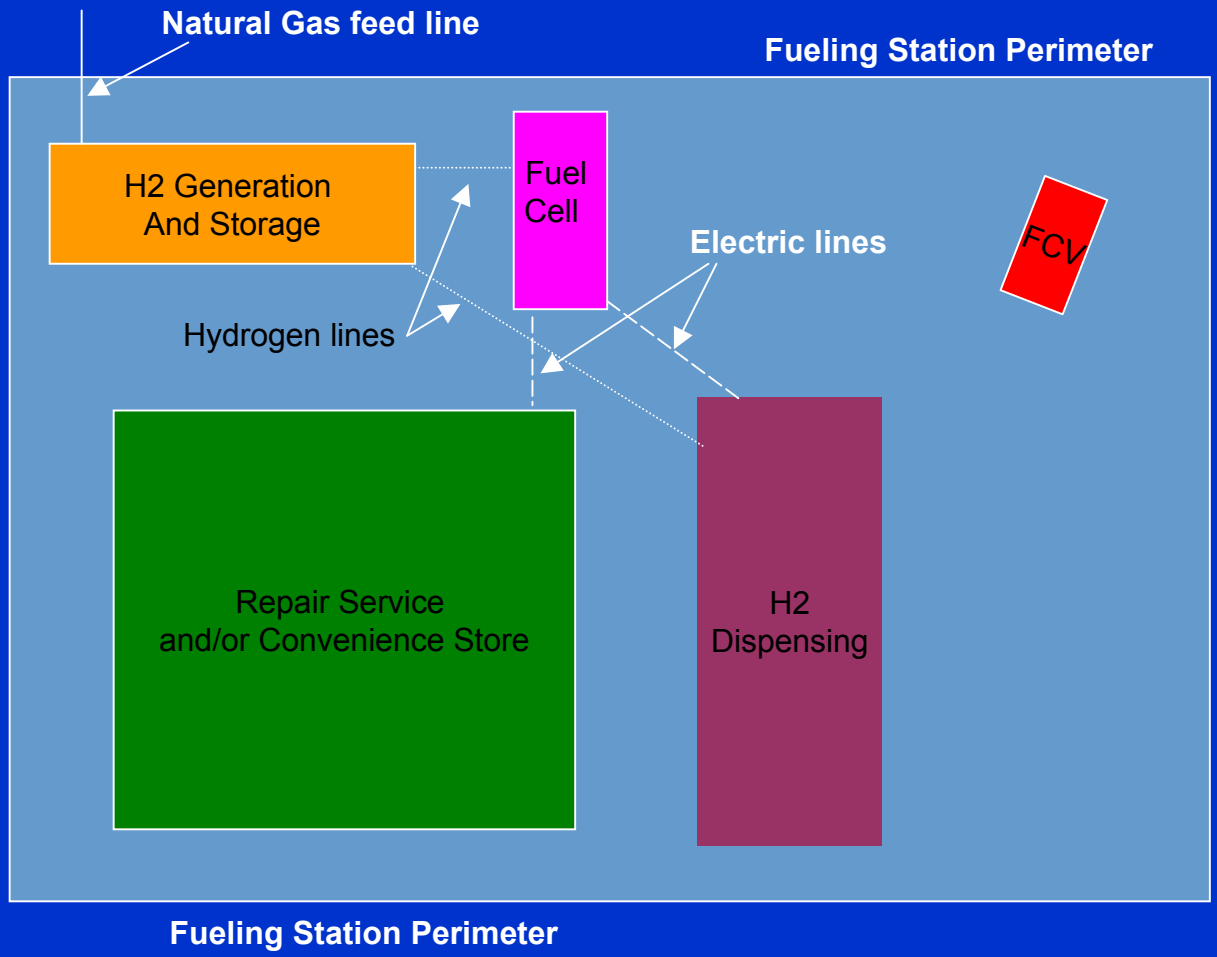
A document covering a narrow subject.

- Some standards, like codes incorporate by reference other standards.
- Examples include NFPA 50A – Standard for gaseous hydrogen systems at consumer sites.

H2 Infrastructure Codes and Standards Policy Considerations

- Safe and reliable hydrogen products available for the consumer (within our lifetime!)
- Consumers and industry have choices on suppliers, components, technologies and products.
- Innovative technologies are not eliminated from consideration.
- Standards do not unfairly or arbitrarily disadvantage one industry segment or nationality over another.

H2 Infrastructure Codes and Standards SDO's involved in fueling station deployment



Construction
- ICC
- NFPA
- Local codes

Electrical
- NEC/NFPA
- IEEE
- ANSI
- Local codes

H2 Dispensing
- SAE

Storage
- NFPA
- CGA
- ASME

FC Vehicle
- SAE
- NHTSA
- DOT

Fuel Cell Power
- ANSI
- UL
- ISO
- IEC

H2 Infrastructure Codes and Standards
Hydrogen Infrastructure Standards Requirements

Model Building Codes

- Design, layout, and construction
- Fire prevention, safety, set-backs…

Component Standards

- Dispenser geometry and interface protocols

Product Standards

- Pressure and purity of hydrogen

Installation Standards

Training Certification

Operation and Maintenance (Performance Standards)

Sensors and Measurement Standards

Recycling and Decommissioning

H2 Infrastructure Codes and Standards U.S. Conformity Assessment System

Conformity Assessment includes:

- **Product sampling and testing**
- **Inspection and certification**
- **Quality and environmental system registration**
- **Standards Development**

In Most Countries, Conformity Assessment:

- **Is overseen & coordinated by a central agency whose goal is eliminating duplication and providing a consistent national system**
- **Coordinates interaction with related international bodies**

H2 Infrastructure Codes and Standards U.S. Conformity Assessment System

In the U.S., Conformity Assessment:

- **Is complex, multifaceted, and includes a combination of voluntary and regulated activities**
- **Includes competing and redundant codes, testing procedures, and certification**
- **Examples:**
  - **49,000 private sector voluntary standards developed by over 600 organizations**
  - **Building and construction codes are numerous and overlapping (state or local jurisdiction)**
  - **Numerous certification organizations.**

H2 Infrastructure Codes and Standards U.S. Code Organizations

U.S. Construction Codes

Typically, construction codes are legislated and enforced by state and local authorities, resulting in hundreds of unique variants, depending on geographical location and political jurisdiction. There are two principle "model codes".

- **International Codes Council**

  Established in 1994 to develop one set of U.S. model construction codes. ICC consists of three supporting agencies (BOCA, ICBO, and SBCCI).

  - **International Building Code, International Fire Code, International Mechanical Code, International Fuel Gas Code.**

- **International Association of Plumbing and Mechanical Officials**

  Maintains a set of model construction codes that are used primarily west of the Mississippi River. Developed and administered cooperatively with NFPA, and the WFCA. These codes are accredited by ANSI.

  - **Uniform Fire Code, Uniform Mechanical Code, National Electric Code, National Fuel Gas Code, NFPA 5000 Building Code, NFPA Fire Prevention Code.**

H2 Infrastructure Codes and Standards
Standards Development

There are two common methods of Code Development:

- **Committee Method**
  - **Balanced matrix of interested groups including industry and government.**
  - **Generally used for major code revisions**
  - **Advantage is in-depth discussion of issues.**
- **Canvass Method**
  - **Internally developed formal draft standards are submitted to a canvass list of other organizations.**
  - **Generally used for minor revisions and updates.**
  - **Advantage is timeliness and breadth.**

H2 Infrastructure Codes and Standards Illustrative Code Development Timeline

ICC Hydrogen Code Development

Spring, 2000

ICC Board of Directors Responds to DOE initiative And appoints H2 Ad Hoc Committee – 9 voting Members and 30 Advisory

Quarterly meetings
For 2 years plus
Draft documents distributed
For industry and government
Comments

Spring, 2002

H2 Ad Hoc Committee Presents code changes to ICC Spring Code Development Hearings (IFC, IFGC, IMC, IRC)

Summer, 2002
Ad Hoc Committee Revised codes via Comments from Spring Meeting

Fall, 2002

Revised ICC Codes Approved in ICC Fall Meeting

ICC Codes
To be published
By EOY, 2002

2003 - 2005

Revised ICC Codes Adopted by Local Jurisdictions

New revisions begun by Ad Hoc Committee

H2 Infrastructure Codes and Standards
Standards Development

Private Standards Development Organizations (SDO's)

In the U.S., the preeminent SDO is the American National Standards Institute (ANSI). ANSI coordinates voluntary standards activities in the U.S., accredits SDO's, approves standards as "ANSI", and manages U.S. participation in the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC).

ANSI Accredited SDO's include:

- **ASTM (American Society for Testing and Materials – the largest U.S. non-governmental SDO**
- **SAE – Society of Automotive Engineers**
- **ASME – American Society of Mechanical Engineers**
- **UL – Underwriters laboratory**
- **NFPA – National Fire Prevention Association**
- **IEEE – Institute of Electric and Electronic Engineers**
- **API – American Petroleum Institute**
- **CGA – Compressed Gas Association**

H2 Infrastructure Codes and Standards Product Certification and Testing

There are three laboratory accreditation systems in the U.S.

- U.S. Dept. of Commerce is charged with coordinating federal, state, and local conformity assessment activities and has set up the National Institute of Standards & Technology (NIST) which operates the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP labs are accredited to international standards.
- A2 Program. American Association for Laboratory Accreditation. These testing labs are internationally accredited.
- OSHA (Occupational Safety & Health Administration) tests electrical products in labs accredited by OSHA, known as Nationally Recognized Testing Laboratories (NRTL's). NRTL's are not accepted internationally.

H2 Infrastructure Codes and Standards Organizations Engaged in H2 Infrastructure

- **ISO TC 197**
  - Working Group 1 – Liquid H2 land vehicle fuel tanks
  - Working Group 5 – Gaseous H2 blends and H2 fuel filling stations & filling connectors (adopted SAE J2600 recently)
  - Working Group 6 – Gaseous H2 and H2 Blends for land vehicle fuel tanks
  - Working Group 7 – Basic considerations for the safety of H2 systems.
- **International Codes Council**
  - Just completed 2 ½ year process to include hydrogen codes in the IFC, IFGC, and IMC.
  - ICC Hydrogen Ad Hoc Committee will likely continue for next two years to make modifications and enhancements to current hydrogen code language for gaseous H2 fuel dispensing applications (among others).

H2 Infrastructure Codes and Standards Organizations Engaged in H2 Infrastructure

- **NFPA (National Fire Prevention Association)**
  - NFPA 52 – Compressed natural gas vehicle fuel systems
  - NFPA 57 Liquid natural gas fuel systems
  - NFPA 50A – Standard for gaseous H2 systems at consumer sites (1999)
  - NFPA 50B – Standard for liquefied H2 at consumer sites – will be consolidated with NFPA 55 (Standard for storage, use, and handling of compressed & liquefied gases in portable cylinders).
- **EIHP (European Integrated Hydrogen Project)**
  - Refueling station layout requirements
  - Refueling interface, procedures, and protocols

H2 Infrastructure Codes and Standards Organizations Engaged in H2 Infrastructure

- **SAE (Society of Automotive Engineers)**
  - Fuel Cell Codes and Standards Committee funded by DOE – coordinated with National Hydrogen Association. Two interface documents:
    - J2600 – Geometry and testing requirements for nozzles and receptacles for gaseous hydrogen on FCV's.
    - J2601 – Compressed H2 surface vehicle communications (between FCV and fueling dispenser).
- **ISO TC 22/SC 21 (International Standards Organization)**
  - Electric Road Vehicles
  - Safety specifications for fuel cell vehicles and H2 fuel systems.
- **JVSA (Japanese Vehicle Standards Association)**
  - Working on interface and performance standards for FCV's.
- **ANSI – American National Standards Institute.**
  - Z21.83 – Standard for stationary fuel cell power system

H2 Infrastructure Codes and Standards Organizations Engaged in H2 Infrastructure

- **IEC TC 105 - International Electrotechnical Commission**
  - Formed in October of 1997. There are seven working groups focusing on terminology, fuel cell modules, safety for stationary FC applications, performance, installation, propulsion, and portable applications.
- **IHIG – International Hydrogen Infrastructure Group**
  - Coordinate standards and infrastructure requirements internationally
- **CSA – Canadian Standards Association**
  - Residential fuel cell power generators, portable FC power, fuel cell modules….
- **UL – Underwriters Laboratory**
  - Product safety testing and certification.
  - UL 2264 – standards for hydrogen generators and dispensers – including reformers, electrolyzers, and sodium borohydrides

H2 Infrastructure Codes and Standards Organizations Engaged in H2 Infrastructure

- **ASME (American Society of Mechanical Engineers)**
  - **ASME PTC 50. This is a performance test code for fuel cell power systems.**
- **IEEE (Institute of Electric and Electronic Engineers)**
  - **IEEE SCC21 Interconnection standards – pertains to fuel cell power systems.**
- **DOE (U.S. Department of Energy)**
  - **HTAP (Hydrogen Technical Advisory Panel) – develop national safety agenda for hydrogen applications**
  - **Codes and Standards Coordinating Committee – monitor and coordinate various voluntary codes initiatives, validate existing flammability and set back standards.**
  - **Freedom Car**
  - **IHIG (International Hydrogen Infrastructure Group)**

H2 Infrastructure Codes and Standards Organizations Engaged in H2 Infrastructure

Five Classifications of C&S Participants:

- **Ownership Organizations.** Create and maintain codes and standards – SAE, IEC, ICC, NFPA, etc…
- **Hard Data Originators.** Testing, certification, and validation of products, components and standards. Includes National Labs, CSA International, UL, NRTL's, etc…
- **Monitor and Facilitation Organizations.** Industry groups with a commercial interest in hydrogen technologies. Includes NHA, USFCC, CaFCP.
- **Codes Enforcement Agencies.** OSHA, State and Local Governments, DOT, NHTSA, etc.…
- **Client Organizations.** These are the companies that manufacture equipment, store fuel, haul goods, and dispense fuel that are governed by hydrogen codes and standards.

H2 Infrastructure Codes and Standards Reasons to Participate with SDO's

- **Minimize product development cost and timing issues.**

  While code development is time consuming, major provisions are generally known to active participants in the process – possibly providing a "head start" to product development.

- **Code Influence.**

  While code-writer's first priority is safety, commercial issues do influence the timing and priority of code writing.

- **Technology Direction.**

  IP is not shared, however the code development process is useful for determining the direction of R&D activities from participants.

- **Contacts.**

  It is a useful forum for identifying which companies are proficient in specific technologies or processes as well as identifying which government agency has oversight of a potential product or business.

H2 Infrastructure Codes and Standards Observations and Commentary

- **There is a tremendous amount of hydrogen expertise available that has not been codified.**
- **Significant gaps within U.S. and international codes are slowly being filled.**
- **There is substantial overlap, complexity, and competition within the code-making "industry" that absorbs resources and slows the overall commercialization process.**
  - **This is mitigated by the overlap in personnel that are involved in similar SDO activities, bringing overall consistency to the process.**
- **Thus far, the absence of codes and standards has not impeded commercialization significantly – but the real test will be over the next five years.**

H2 Infrastructure Codes and Standards Web Sites and Contacts

National Hydrogen Association http://www.hydrogenus.org

California Fuel Cell Partnership
http://www.drivingthefuture.org/

DOE H2 Information Network
http://www.eren.doe.gov/hydrogen/

US Fuel Cell Council http://www.usfcc.com

International Code Council http://www.intlcode.org

National Fire Prevention Association (NFPA)
http://www.nfpa.org